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ORIGINAL ARTICLE

A less invasive surgical approach in the lumbar lateral recess stenosis: direct approach to the medial wall of the pedicle

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Abstract The lateral recess is one of the main compression sites in lumbar spinal canal stenosis. Lumbar nerve root is mainly entrapped by bony tissue in compression syndrome. The patient has a long history of back pain in conjunction with claudication symptoms. Besides laminotomy and facetectomy techniques, several specific surgical approaches to treat the lateral recess stenosis have been described. The surgical technique of bilateral lateral recess decompression via subarticular fenestrations used in this study is a less invasive technique, which enables to decompress the neural structures while preserving as much of the bony structures and ligamentum flavum as preferred. In 16 patients, we measured lateral recess heights with computerized tomography. The number of involved lumbar segments was one in 11 patients and two in 5 patients. The visual analogue scale (VAS) results were maintained before, 3 and 12 months after the operation. All patients benefited from the operations. Mean VAS scores were 7.0, 5.5, and 4.0, respectively. There were not any surgery-related complications. Mean follow-up period is 22.6 months. The surgical technique described and used in this study provides easy access to every zone of lateral recess and is safe and effective in treating the lumbar lateral recess stenosis syndrome.

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Introduction

In 1955, Schlesinger and in 1972, Epstein et al. reported some cases and described the clinical and radiographic findings of facet syndrome. They pointed out the importance of the height of the intervertebral foramen on plain radiographs in narrow lateral recess cases [11, 38]. Since then several authors recognized and described lateral recess stenosis and lateral entrapment syndrome [8, 25, 26, 31, 37, 40]. Lee et al. further defined the anatomy of lateral recess and the lateral canal stenosis [26].

The lateral recess has been reported as the principal compression site in lumbar spinal canal stenosis [1, 2, 8, 12, 21, 23]. The cause of these neuropathies has been attributed to entrapment by bony tissue [23]. Clinically, lumbar nerve root compression syndrome is seen in persons above 50 years of age. Lateral recess stenosis frequently occurs without disk protrusion,but clinically presents with similar radiculopathy [8]. The patient typically complains of severe radiating pain during the day that keeps him up at night [22].

During the functional examination, if the compression lies in the intervertebral foramen, trunk extension in combination with ipsilateral side bending and rotation can provoke the lumbar root related pain [42]. Surgical decompression relieves leg symptoms of these patients [3].

The lateral recess is the region of the lumbar canal that is bordered laterally by the pedicle, posteriorly by the superior articular facet and ligamentum flavum, and anteriorly by the vertebral body, endplate margin, and disk margin [6, 8, 11, 33]. The recess is funnel-shaped, and is the narrowest in its cranial part at the superior border of the pedicle [31]. Lee et al. classified this region into three zones; entrance, mid and exit zones. Entrance zone has only anterior and posterior walls. The anterior wall is the posterior surface of the disc, and the posterior wall is the superior articular process. The neural structure contained in this zone is the lumbar nerve root, covered by the dura mater and bathed in cerebrospinal fluid. The anterior border of mid zone is the posterior aspect of the vertebral body. The posterior border is the pars interarticularis and the medial border is open to the central vertebral canal. The neural structures contained in this zone are the dorsal root ganglion and ventral motor nerve root (funiculus), which are covered by a fibrous connective tissue extension of the dura mater. These neural structures are also bathed in cerebrospinal fluid. The exit zone is the area surrounding the intervertebral foramen. The neural structure contained in exit zone is the lumbar peripheral nerve, which is covered by perineurium [28].

The spinal nerve root leaves the dural tube, descends obliquely downward and outward through the lateral recess, and emerges under the pedicle via the foramen. In case of thickening of the superior articular facet, the nerve root is affected throughout this oblique course. As the nerve root approaches the pedicle, the canal forming the lateral recess becomes smaller; thus thickening of the facet is more likely to compress the nerve root at the superior border of the pedicle [8, 11].

The superior facet of the lower vertebrae may cause radicular pain in three ways in the level above (that is, the S-1 superior facet causing L-5 pain): (1) the facet may migrate upward causing a phenomenon called “facet impingement, (2) the facet may have degenerative osteoarthritic changes, and (3) encroachment of chondrocartilaginous material from the facet joint onto the nerve may take place. Other authors have addressed radiculopathy caused by spondylolysis, spondylolisthesis, lateral discs, pedicular kinking, and migration of the disc into the foramen [6, 14, 15, 20, 27].

The ligamentum flavum is confluent with the anterior capsule of the facet joint and closes the posterior spinal canal between the lamina. High-elastin fiber content of the ligament provides capsular flexibility coupled with elastic stability to the posterior axial skeletal mechanism. The ligament is continuously pre-tensioned in all positions of the spine, precluding any anterior buckling of the normal facet joint capsule into the spinal canal. However, this ligament demonstrates a potential for hypertrophy with chronic inflammation and or hypermobility and acts as a key contributor to nerve root compression syndrome [5].

Although classical laminotomy and facetectomy techniques are still applied, several specific surgical approaches to treat the lateral recess stenosis have been described. In this study, a less invasive surgical technique used to treat lateral recess stenosis is described.

Materials and methods

Sixteen consecutive symptomatic patients with degenerative lumbar lateral recess stenosis were enrolled in the study. The history of complaints was maintained. The patients were examined and pain was evaluated using a visual analog scale (VAS) pre- and postoperatively [19].

All patients had lumbar stenosis limited to the lateral recess only. The presence of lateral recess stenosis in patients was confirmed using computed tomography and magnetic resonance imaging. The patients with disc herniations were not included in the study.

The lateral recess was measured bilaterally at the stenotic level. The measurements were performed at the computed tomography screen, by positioning the cursor on the suitable reference point using a trackball. The distance between the posterior edge of the vertebral body and the anterior part of the articular facet was measured in the pedicular slice at the level of the upper vertebral platform. Lateral recess stenosis was diagnosed when the nerve root was found to be trapped in the bony margins of the lateral recess or foramen with clinical symptoms or signs attributable to this root (Table 1).

Surgical technique

The positioning of the patient on the operating table is similar to that for routine lumbar discectomy and requires the same care to obtain adequate flexion at hip joint without excessive pressure on the abdomen. A short midline incision centered over the relevant interspace(s) is planned. On the planned side, the paraspinal muscles are elevated off the underlying ligaments and bone in the subperiosteal plane.

The surgeon is faced with hypertrophied facet joint, largely obscuring the underlying ligamentum flavum. Sometimes hypertrophied distal end of inferior articular facet may be overlying the junction of facet-caudal lamina are,a but there is almost always evidence of hypertrophy of the facet joint synovia that extends in a redundant fashion outside the joint. Using an operating microscope, surgical debridement of the hypertrophied synovia is applied and if present the hypertrophied distal end of inferior articular facet is drilled away with a high-speed drill.

Once the working space over the caudal lamina area, adjacent to the facet has distinctly been defined to the edge of the facet capsule, drilling of the lamina begins from the superomedial edge and over the ligamentum flavum (Fig. 1). As drilling continues anterolaterally, the

Table 1 Operated spinal levels, lateral recess measurements (operated levels are written in bold), preoperative and postoperative VAS scores of patients

Case no	Age	Sex	Duration of symptoms (years)	Operated levels	Lateral recess height (mm)		VAS scores		
					Right	Left	Pre-op	Post-op third month	Post-op twelfth month
1	42	M	3	L5–S1	3.6	**3.5**	6.5	5.5	4.0
2	63	M	12	L4–5	**2.7**	**2.8**	9.8	7.7	4.0
3	65	F	2	L5–S1	3.2	**3.3**	3.2	3.0	3.0
4	53	M	4	L3–4	**3.0**	3.0	5.5	5.0	3.5
5	71	F	7	L4–5	**2.4**	**2.3**	6.7	5.0	5.0
6	62	M	4	L4–5	2.5	**2.4**	5.8	0.0	0.0
7	45	M	3	L5–S1	3.2	**3.1**	6.3	6.0	5.0
8	42	F	4	L3–4	**3.1**	2.9	7.3	6.0	6.0
9	56	M	4	L4–5	**2.2**	2.0	5.6	5.5	4.0
10	66	M	2	L4–5	**2.4**	**2.5**	8.7	7.8	7.0
11	53	M	3	L3–4	3.3	**2.9**	6.7	6.0	5.6
12	52	F	7	L3–4	**3.1**	2.9	8.6	6.0	3.0
13	65	M	2	L4–5	2.1	**2.0**	8.7	6.6	4.2
14	53	F	5	L4–5	**2.1**	**2.1**	5.6	4.3	2.0
15	45	F	3	L3–4	**2.3**	**2.2**	8.8	8.0	4.0
16	47	F	6	L4–5	**3.1**	2.9	9.3	6.0	4.3
Mean	52		4.4		2.7	2.6	7.0	5.5	4.0

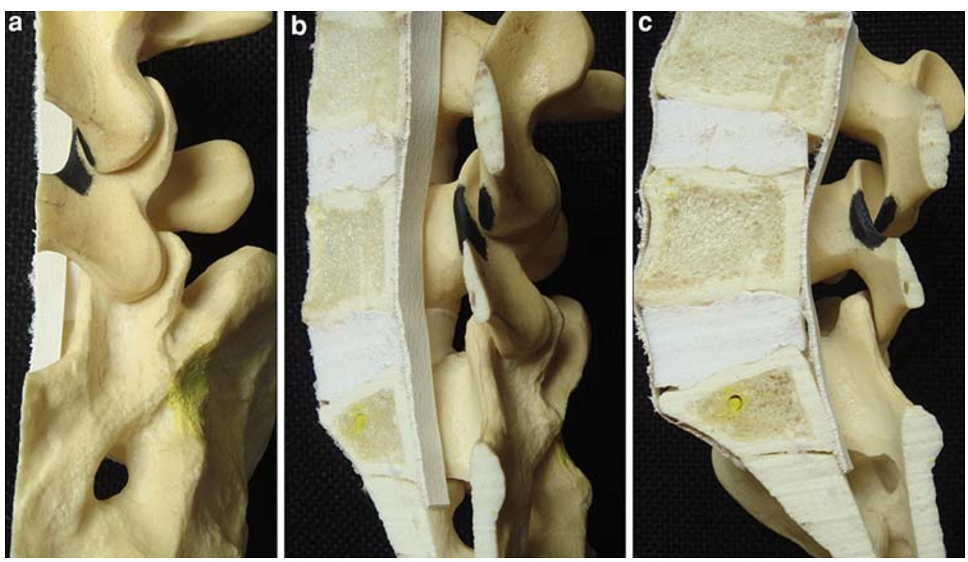

Fig. 1 Bony area to be drilled away at the beginning of operation is shown in the L4–5 level of the lumbar spine from posterior (**a**), postero-medial side (**b**) and from the medial side (**c**)

lateral edge of ligamentum flavum is freed and the medial wall of the pedicle is distinguished. The mid zone of the lateral recess is reached and the stenosis within this zone is already treated when the medial wall is clearly and straightly encountered (Fig. 2). Using a Murphy ball hook, superior and inferior walls of the pedicle is controlled. The mid zone is entirely exposed till the levels of these two walls are reached. From this point, the operation may be directed to either side; to entry and/or exit zone.

The drill-away work is extended caudally parallel to the medial wall of the pedicle. The exit zone and the exiting nerve root in the inferolateral edge of the ligamentum flavum are exposed. The necessary extent of decompression is determined by controlling the sides of the root by the help of Murphy ball hook. The last step of the decompression is completed by undercutting the lamina using fine Kerrison rongeur.

For entry zone stenosis, the decompression is continued cranially after relieving mid zone. Changing the angle of

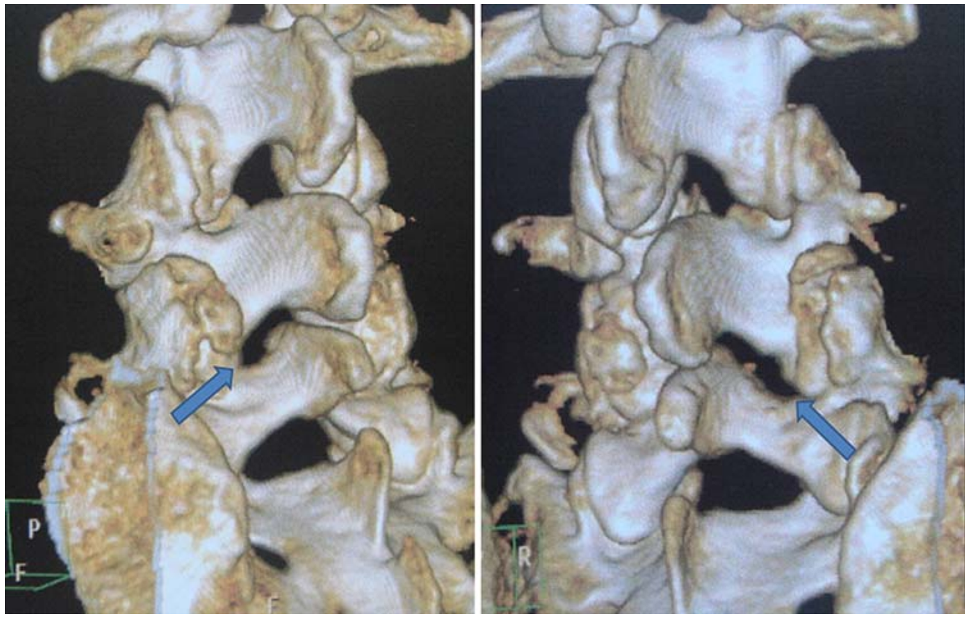

Fig. 2 Postoperative 3-D reconstruction CT scan of the lumbosacral spine. *Arrows* point the area of operation. Note the bilateral facet complex degeneration at the relevant level

operating microscope slightly in the caudo-cranial direction maintains more visualization. Drilling the medial aspect of facet complex over the ligamentum flavum is developed anteriorly and cranially. It is almost always possible to decompress this zone by drilling the medial superior articular facet without penetrating the ligamentum flavum. The ligament maintains a safe working area. The facetectomy must not exceed laterally the line which is tangential to medial wall of the pedicle. The extent of decompression can be determined using Murphy ball hook, again.

Results

Seven patients were female and nine patients were male. Their mean age was 52 years (range 42–71 years). All patients in study group complained of leg pain with or without back pain. The leg pain was in the form of neurogenic claudication. The patients complained of intense, disabling pain in one or both legs, brought on by standing and walking. Ten patients had bilateral radicular pain. The pain in six patients was radiating to one leg. The pain was relieved mostly by sitting, lying down or squatting. Mean symptom duration was 4.4 years and was ranging between 2 and 12 years. Six of the patients had lower extremity sensory loss and three had mild lower-extremity weakness.

Features of stenosis in CT scans are also presented in Table 1. The number of involved lumbar segments was 1 in 11 patients and 2 in 5 patients. Five patients were operated bilaterally on two levels and five other patients were operated bilaterally on single level. Six patients were operated unilaterally on single level (Fig. 3). Pre- and postoperative VAS scores are shown in Table 1. Mean preoperative score is 7.0. It is 5.5 in the third month and 4.0 at the end of first year postoperatively.

Lateral lumbar spine flexion–extension radiography was performed in all patients in the third-month follow-up evaluations. Radiographs were evaluated by a radiologist and no evidence of spinal instability was found. The postoperative follow-up period ranged from 15 to 34 months (mean 22.6 months).

There were no surgery-related complications. All the patients were mobile the day after the operation. Fourteen patients obtained complete relief of symptoms, but back pain of two patients (patients 10 and 11) did not resolve completely, however, the legs were free of pain. Satisfactory VAS scores were obtained at the final follow-up evaluations of all of the patients. Final follow-up time of the patients did not span homogeneity (from 15 to 34 months), so we did not compare their final VAS scores.

For statistical evaluation of the preoperative and postoperative VAS scores, Wilcoxon Signed Ranks Test was performed. Both preoperative–postoperative third month and preoperative–postoperative twelfth month VAS score differences were significant ($P < 0.005$).

Discussion

Lateral lumbar spinal canal connects the intraspinal space and the extraspinal space. Each zone of the lateral lumbar spinal canal has its own characteristic shape, contents and pathology, and therefore each zone requires different techniques of surgical decompression [28].

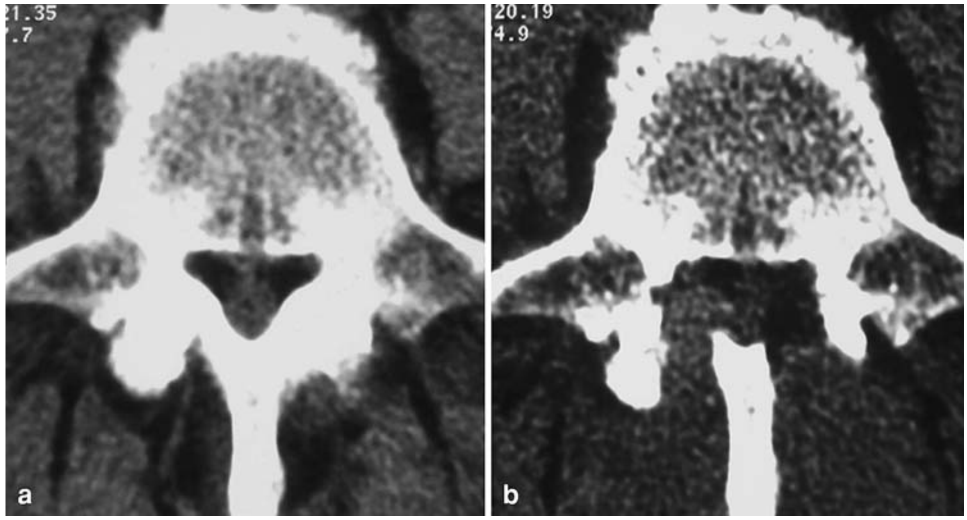

Fig. 3 Preoperative (**a**) and postoperative (**b**) CT scans of a patient

The most common cause for entrance zone stenosis is hypertrophic osteoarthritis of the facet joint, particularly involving the superior articular process. Two common causes for mid zone stenosis are osteophyte formation under the pars interarticularis where the ligamentum flavum is attached, and fibrocartilaginous or bursal tissue hypertrophy at a spondylolytic defect. Common causes for exit zone stenosis are hypertrophic osteoarthritis changes of the facet joints with subluxation and osteophytic ridge formation along the superior margin of the disc. Mid zone stenosis caused by localized bony hypertrophy under the pars interarticularis is almost always accompanied by other types of stenosis–exit stenosis of the same lateral canal or entrance stenosis of the lateral canal below [28]. Facet degeneration was considered due to hypertrophic changes or osteophyte formation, periarticular calcification, articular narrowing of the joint space, vacuum phenomenon, or subchondral erosion [36].

Radiculopathy associated with a stenotic spinal canal or lateral recess is well recognized [8, 10, 11]. In lateral lumbar spinal canal stenosis, a single spinal nerve may be entrapped at three different zones across two spinal motion segments, and pathologic conditions at a single vertebral level may entrap two different spinal nerves within two different zones of the lateral lumbar spinal canal. Successful results of surgical decompression of lateral lumbar spinal canal stenosis will depend on understanding the precise locations and types of pathologic conditions and on application of appropriate surgical decompression techniques for each zone [28].

Root compression in the lateral recess typically occurs in two morphologic forms: in the first form, a congenital trefoil-shaped lateral recess is present initially. The recess becomes smaller and root compression occurs as the superior articular facet hypertrophies or the disk margin enlarges because of endplate spur or disk bulging [3]. The second form is angular pinch-like encroachment of the lateral margin of the canal with subsequent pinch of the nerve root. An acute angle shape of the recess ensues because of the progressive facet, endplate and disk margin changes. This leads to displaced, pinched, and compressed nerve root within this region. If early facet hypertrophy occurs, an acquired trefoil-shaped canal ensues [3].

In pure lateral recess syndrome, the nerve root is entrapped under the superior articular facet. Surgical management consists of decompressing the nerve root emerging from the thecal sac along its entire course in the radicular canal with laminotomy and medial facetectomy. This achieves satisfactory decompression. If lumbar disc herniation accompanies the pathology, removal of disc material is needed additionally [34].

Several different surgical techniques for lateral recess syndrome have been described. Besides extensive procedures of laminectomy, bilateral multilevel fenestration and bilateral fenestration restricted to the clinically relevant level have been used [2, 4, 7, 13, 17, 18, 24, 29, 32, 35, 41, 43]. Some fenestration studies are focused on the symptomatic stenotic side and if present, the contralateral asymptomatic but stenotic lateral recess is ignored [29, 32].

Lee et al. recommend medial facetectomy to 50% and removal of an osteophytic ridge along the disc if needed for entrance zone stenosis. For mid zone stenosis, they recommend total facetectomy and laminectomy or careful excision and curettage under the pars interarticularis after medial facetectomy. Trimming of the osteophytes along the superior margins of the superior articular process and if needed trimming of the osteophytes along the lateral margins of the corresponding inferior articular process are also suggested for exit zone stenosis [28]. For exit zone stenosis, Maher and Henderson advocate approaching the foramen from the interlaminar space below the level of the root; that is, between the L-5 and S-1 laminae for an L-5 root compression [29]. Laminal fenestration techniques have also been described for exit zone stenosis [9, 39].

The surgical techniques directed to lateral recess stenosis are in tendency of being less invasive compared to the previous ones. The aim is to be less destructive when decompressing the stenotic area. Almost all described techniques have common hallmark of facetectomy. However, to what degree the facetectomy must be performed is uncertain. The suggested amount of medial facetectomy is ranging from one-third to one-half [4, 28]. Performing the aforementioned operative techniques is not practical in the operation with only posteromedial exposure of the facet complex. Indeed, nobody can be sure of the quantity of facetectomy made. As an advantage, the presented technique enables to determine the inevitable limits of facetectomy. In this technique, the surgeon first reaches the medial wall of the pedicle in the canal and directs the operation to the planned way, caudally, cranially or both. The technique presented by Hejazi is somewhat similar to our technique, but he applied a more limited form of ours to treat retrovertebral lumbar disc herniations [16].

There are some other advantages of the described technique. The ligamentum flavum is left intact as preferred and the lamina parts that are not responsible for stenosis are selectively spared. The latter characteristics will lead to minimal epidural fibrosis, and thus will provide a much easier reoperation of the same area if required.

Conclusions

Our results show that even bilateral lateral recess decompression at two levels via subarticular fenestrations lets early mobilization of patients without impending instability. The technique is effective in treating the lateral recess stenosis. Minimal bony defect averts prolonged postoperative pain and immobility, which are well depicted sequelae of extensive bony decompression.

The advantage of being able to leave the ligamentum flavum in place and most of the laminae provides less scar formation and an advantage for a probable reoperation. Instructive data obtained from clinical observations of our patients propose lateral recess decompression as a sound alternative to wide laminectomy for lateral recess stenosis patients.

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